Medical

High Specification Tubing Solutions for Critical Medical Applications
HIGH PRECISION TUBES FOR DEMANDING ENVIRONMENTS

MEDICAL

TUBING EXCELLENCE

With over 70 years of engineering expertise in supplying high-precision tubes, Superior Tube and Fine Tubes work closely with customers worldwide, developing high-specification tubing solutions to help them solve their technical challenges. We manufacture high-performance tubes for supercritical medical applications in an ever-expanding range of stainless steel, titanium and other specialty alloys.

TUBING INNOVATIONS

Superior Tube and Fine Tubes benefit from a world-class reputation for innovative and high-quality tubing solutions geared towards the medical industry. Here are a few examples:

- **1936** Superior Tube manufactures hypodermic needle tubing for critical medical instruments including catheters and cystoscopies.
- **1970** Superior Tube develops 316 stainless steel tubing for life-saving artificial kidney machines.
- **1980** Superior Tube produces precision needle tubing for the “Radiation Implanter” - a medical device for the treatment of cancerous tumors.
- **1997** Superior Tube receives its first order for advanced L605 (cobalt-chromium) alloy tubing related to coronary stents.
- **2002** Fine Tubes develops profiled implant tubing for medical applications.
- **2003** Superior Tube’s proprietary tube rolling process is used to produce titanium alloy tubing for artificial heart valve frames.
- **2004** Fine Tubes manufactures Ti 6Al-4V (Grade 5) tubing for femur and tibia bone nail implants.
- **2009** Superior Tube receives an award for its role in the development and market introduction of innovative transaortic valve replacements.
TUBING SOLUTIONS

MEDICAL

For over seven decades, design engineers have been relying on Superior Tube and Fine Tubes, two of the medical industry's most technologically advanced manufacturers of highly engineered, small-diameter, precision alloy tubing.

The demand for high-performance stainless steel and titanium alloys that can offer excellent strength-to-weight ratios is constantly increasing. This, in combination with high levels of microbiological corrosion resistance and fatigue life properties, is the challenge that has been exceeded by our biocompatible medical materials.

We have the technical capability to achieve an OD surface finish down to 16μ in (0.4μ m) Ra or better with centerless grinding and an ID surface finish down to 8μ in (0.2μ m) Ra or better with electropolishing.

From advanced alloy precision tubing development to everyday inventory management challenges, we're ready to partner with you to help develop solutions for your unique requirements.

MEDICAL APPLICATIONS:

- Angioplasty and embolism
- Auto injection systems
- Biopsy needles
- Catheters
- Cannulas
- Cardiac electrodes
- Cardiac rhythm management
- Coronary and peripheral stents
- Dental implants
- Drug delivery
- Endoscopy equipment and instruments
- Heart valves
- Lag screws
- Neuromodulation devices
- Nuclear medicine
- Peripheral stents
- Spinal cages and screws
- Surgical implants
- Surgical instruments and tools
- Trauma nails and screws
- Trauma and orthopedic implants
HIGH PRECISION TUBES FOR DEMANDING ENVIRONMENTS
MEDICAL

MANUFACTURING CAPABILITIES

ALLOYS

Superior Tube and Fine Tubes produce a wide range of custom-sized tubing in an ever expanding range of alloys – available in three different forms, i.e. seamless, welded or welded & redrawn (Weldrawn®) finish.

<table>
<thead>
<tr>
<th>SEAMLESS, WELDED, WELDED &amp; REDRAWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless Steel</td>
</tr>
<tr>
<td>304L, 316L, 316LVM, 15-5PH, 17-4PH, 17-7PH</td>
</tr>
<tr>
<td>Titanium</td>
</tr>
<tr>
<td>Ti CP (Grade 1 and Grade 2), Ti 3Al-2.5V (Grade 9), Ti 6Al-4V (Grade 5), Ti 6Al-4V ELI (Grade 23)</td>
</tr>
<tr>
<td>Specialty</td>
</tr>
<tr>
<td>35NLT, L605, MP3SN™, Nitronic 50™, Tantalum</td>
</tr>
</tbody>
</table>

We also manufacture tubing in many other grades. Please contact us for more details.

SIZE RANGE

Size range for medical products is based upon manufacture of cold drawn tubing from 0.012 in (0.30 mm) to 2 in (50.8 mm) OD. Tolerances: OD and ID up to 0.0005 in (0.0127 mm) are achievable.

PRODUCTION FACILITIES

- Pilger mills
- Multi-roll rolling mills
- Draw benches
- Tube welding mills - In-line weld mills
- Controlled atmosphere heat treatment
- Bright annealing/hydrogen furnace
- Vacuum annealing
- Pickling & passivation plant
- NDT ultrasonic & eddy current testing
- Hydrostatic testing
- Radiographic examination
- Electropolishing capabilities
- Full chemical and physical laboratory analysis
## Supercritical Tubing • Grade Chart

### Medical

<table>
<thead>
<tr>
<th>ALLOY UNS No.</th>
<th>WNr</th>
<th>C</th>
<th>Mn</th>
<th>Ni</th>
<th>Cr</th>
<th>Fe</th>
<th>Mo</th>
<th>Ti</th>
<th>Nb</th>
<th>N</th>
<th>Al</th>
<th>Other</th>
<th>Density</th>
<th>Temp</th>
<th>Tensile Rm (min)</th>
<th>Yield Rp 0.2% (min)</th>
<th>Elong. % min</th>
<th>Hardness HV</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>304L</td>
<td>1.4306</td>
<td>0.035</td>
<td>2.0</td>
<td>8.0-11.0</td>
<td>18.0-20.0</td>
<td>bal</td>
<td>2</td>
<td>0.25-2.5</td>
<td>25-3</td>
<td>7.93</td>
<td>0.286</td>
<td>AN</td>
<td>N</td>
<td>70</td>
<td>485</td>
<td>25</td>
<td>170</td>
<td>35</td>
<td>200</td>
</tr>
<tr>
<td>316L</td>
<td>1.4404</td>
<td>0.035</td>
<td>2.0</td>
<td>10.0-13.0</td>
<td>16.0-18.0</td>
<td>bal</td>
<td>2.0</td>
<td>3.0</td>
<td>7.03</td>
<td>0.286</td>
<td>AN</td>
<td>N</td>
<td>70</td>
<td>485</td>
<td>25</td>
<td>170</td>
<td>35</td>
<td>200</td>
<td>Standard AOD melt austenitic stainless steel grade.</td>
</tr>
<tr>
<td>316VM</td>
<td>1.4435</td>
<td>0.030</td>
<td>2.0</td>
<td>11.0-14.0</td>
<td>17.0-19.0</td>
<td>bal</td>
<td>2.0</td>
<td>3.0</td>
<td>7.93</td>
<td>0.286</td>
<td>AN</td>
<td>N</td>
<td>70</td>
<td>485</td>
<td>25</td>
<td>170</td>
<td>35</td>
<td>200</td>
<td>Vacuum remelt or ESR to achieve highest microcleanliness levels and structural homogeneity.</td>
</tr>
<tr>
<td>15-5PH</td>
<td>1.4545</td>
<td>0.070</td>
<td>2.5-3</td>
<td>3.5-5.5</td>
<td>14.5-15.5</td>
<td>bal</td>
<td>0.15-0.45</td>
<td>Cu 2.5-4.5</td>
<td>7.8</td>
<td>0.282</td>
<td>HT</td>
<td>155</td>
<td>1070</td>
<td>145</td>
<td>1000</td>
<td>12</td>
<td>331</td>
<td>Capable of developing high mechanical properties by solution treatment and age hardening.</td>
<td></td>
</tr>
<tr>
<td>17-4PH</td>
<td>1.4542</td>
<td>0.070</td>
<td>2.0</td>
<td>3.0-5.0</td>
<td>15.0-17.5</td>
<td>bal</td>
<td>0.15-0.45</td>
<td>Cu 3.0-5.0</td>
<td>7.9</td>
<td>0.286</td>
<td>HT</td>
<td>155</td>
<td>1070</td>
<td>145</td>
<td>1000</td>
<td>5</td>
<td>300</td>
<td>Capable of developing high mechanical properties by solution treatment and age hardening.</td>
<td></td>
</tr>
<tr>
<td>17-7PH</td>
<td>1.4568</td>
<td>0.09</td>
<td>1.0</td>
<td>6.5-7.75</td>
<td>16.0-18.00</td>
<td>bal</td>
<td>Al 75/15</td>
<td>7.81</td>
<td>0.282</td>
<td>AN</td>
<td>140</td>
<td>965</td>
<td>35</td>
<td>241</td>
<td>20</td>
<td>222</td>
<td>Precipitation hardening grade often used for surgical instruments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35Nlt</td>
<td>2.4999</td>
<td>0.025</td>
<td>1.05</td>
<td>3.0-5.0</td>
<td>bal</td>
<td>0.1-0.3</td>
<td>0.2-0.4</td>
<td>Cu 2.5-4.5</td>
<td>7.80</td>
<td>0.285</td>
<td>HT</td>
<td>155</td>
<td>1070</td>
<td>145</td>
<td>1000</td>
<td>35</td>
<td>285</td>
<td>Nitrogen strengthened austenitic grade with exceptional strength in the cold-worked condition.</td>
<td></td>
</tr>
<tr>
<td>1605</td>
<td>2.4964</td>
<td>0.5-1.0</td>
<td>1.0-2.0</td>
<td>9.0-11.0</td>
<td>19.0-21.0</td>
<td>3.0</td>
<td>W 14.0-16.0</td>
<td>9.10</td>
<td>0.330</td>
<td>AN</td>
<td>160</td>
<td>1104</td>
<td>95</td>
<td>655</td>
<td>35</td>
<td>266</td>
<td>Cobalt chrome alloy ideal for implantable applications.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP35n™</td>
<td>R30035</td>
<td>0.03</td>
<td>0.2</td>
<td>3.30-3.70</td>
<td>19.0-21.0</td>
<td>1.0</td>
<td>max</td>
<td>9.0-10.5</td>
<td>1.0 max</td>
<td>Co bal</td>
<td>8.43</td>
<td>0.304</td>
<td>AN</td>
<td>190</td>
<td>1310</td>
<td>130</td>
<td>896</td>
<td>40</td>
<td>213</td>
</tr>
<tr>
<td>Nitronic 50™</td>
<td>R30201</td>
<td>0.06</td>
<td>4.0</td>
<td>11.5-13.5</td>
<td>20.5-23.5</td>
<td>bal</td>
<td>1.5-3.0</td>
<td>0.1-0.3</td>
<td>0.2-0.4</td>
<td>V</td>
<td>0.1-0.3</td>
<td>Co</td>
<td>Bal</td>
<td>8.10</td>
<td>0.304</td>
<td>AN</td>
<td>190</td>
<td>1310</td>
<td>130</td>
</tr>
<tr>
<td>Tantalum</td>
<td>3.7025</td>
<td>0.8</td>
<td>0.20</td>
<td>max</td>
<td>bal</td>
<td>0.05</td>
<td>Ta Bal</td>
<td>16.61</td>
<td>0.60</td>
<td>AN</td>
<td>75</td>
<td>517</td>
<td>35</td>
<td>241</td>
<td>25</td>
<td>120</td>
<td>Commercially pure tantalum.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP Grade 1</td>
<td>R50250</td>
<td>0.08</td>
<td>max</td>
<td>0.20</td>
<td>max</td>
<td>bal</td>
<td>0.03</td>
<td>max</td>
<td>4.48</td>
<td>0.162</td>
<td>AN</td>
<td>N</td>
<td>80</td>
<td>552</td>
<td>70</td>
<td>482</td>
<td>15</td>
<td>The most ductile and softest titanium alloy. A good solution for cold forming and corrosive environments.</td>
<td></td>
</tr>
<tr>
<td>CP Grade 2</td>
<td>R50400</td>
<td>0.08</td>
<td>max</td>
<td>0.30</td>
<td>max</td>
<td>bal</td>
<td>0.03</td>
<td>max</td>
<td>0.25</td>
<td>max</td>
<td>4.51</td>
<td>0.163</td>
<td>AN</td>
<td>N</td>
<td>50</td>
<td>345</td>
<td>4065</td>
<td>275</td>
<td>450</td>
</tr>
<tr>
<td>Ti 3Al-2.5V</td>
<td>Grade 9 R55320</td>
<td>0.08</td>
<td>max</td>
<td>0.25</td>
<td>max</td>
<td>bal</td>
<td>0.03</td>
<td>max</td>
<td>2.5-3.5</td>
<td>3.0</td>
<td>V</td>
<td>2.0-2.5</td>
<td>4.48</td>
<td>0.162</td>
<td>CWSR</td>
<td>125</td>
<td>860</td>
<td>105</td>
<td>725</td>
</tr>
<tr>
<td>Ti 6Al-4V</td>
<td>Grade 5 R56400</td>
<td>0.30</td>
<td>max</td>
<td>0.40</td>
<td>max</td>
<td>bal</td>
<td>0.05</td>
<td>max</td>
<td>5.5-6.75</td>
<td>V</td>
<td>3.5-4.5</td>
<td>4.43</td>
<td>0.160</td>
<td>AN</td>
<td>N</td>
<td>50</td>
<td>345</td>
<td>40</td>
<td>275</td>
</tr>
<tr>
<td>Ti 6Al-4V</td>
<td>Grade 23 EU R56401</td>
<td>0.30</td>
<td>max</td>
<td>0.40</td>
<td>max</td>
<td>bal</td>
<td>0.05</td>
<td>max</td>
<td>5.5-6.75</td>
<td>V</td>
<td>3.5-4.5</td>
<td>4.43</td>
<td>0.160</td>
<td>AN</td>
<td>N</td>
<td>50</td>
<td>345</td>
<td>40</td>
<td>275</td>
</tr>
</tbody>
</table>

For further details on our grades visit:

www.superiortube.com/products/our-grades
www.finetubes.co.uk/products/tube-grades
TUBING QUALITY

INTEGRITY ASSURANCE

The quality control process at Superior Tube and Fine Tubes is critical in respect of consistently achieving the highest level of specification requirements.

Reduction control through pilgering and drawing is specific to each product dimension and specification requirements. This is the driver for tolerance control, OD and ID surface finish control, inclusion levels and final grain size.

- OD surface roughness typically better than 30μ in (0.75μ m) Ra.
- ID surface roughness typically better than 59μ in (1.5μ m) Ra.

Rigorous process control ensures that grain sizes typically achieve levels finer than ASTM 8 per ASTM E112. Testing capabilities include non-destructive ultrasonic, eddy current and hydrostatic testing.

TUBE ADVANTAGES

High levels of ID and OD surface finish, tolerance and ovality controls yield a product that is a cost-competitive alternative to the gun-drilled technology. At the same time, it can offer additional benefits of consistency and small inside diameters over typical lengths of 10 ft (3 m).

- OD surface roughness can be further refined by centerless grinding down to 16μ in (0.4μ m) Ra or better.
- ID surface roughness can be further refined by drawing down to 16μ in (0.4μ m), then electro-polished to achieve 8μ in (0.2μ m) Ra or better.

ID defect levels: UT tested to levels down to 50 microns (0.0020 in/0.05 mm).

Fatigue life: Control of texture combined with extra low levels of interstitial impurities leads to higher fatigue performance than equivalent drilled bars.

Tolerances: In-house control to ISO 286-2 h8.

<table>
<thead>
<tr>
<th>OUTSIDE DIAMETER</th>
<th>TOLERANCE +/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>inches</td>
</tr>
<tr>
<td>6 - 10</td>
<td>0.23 - 0.39</td>
</tr>
<tr>
<td>&gt;10 - 18</td>
<td>&gt; 0.39 - 0.70</td>
</tr>
<tr>
<td>&gt;18 - 30</td>
<td>&gt; 0.70 - 1.81</td>
</tr>
</tbody>
</table>

ID/OD ratio: Tube production can be controlled over full length to maintain small IDs from 0.3 to 0.15 of OD.

TUBING QUALITY STANDARDS

- ASTM F136-Ti6-4 ELI
- ASTM F138-316L-316LVM
- ASTM F1314-22Cr-13Ni-5Mn
- BS ISO 5832-9
- ISO-DIS 25832-1
In addition to tube mills in the United Kingdom and the United States, we have sales offices in Germany, France, India and the United States, as well as an extensive network of partners in Asia, Europe and the Middle East.

Our tubing experts deliver high-precision tubing to customers in over 35 countries worldwide.

GLOBAL SALES OFFICES AND AGENTS NETWORK

- MILL LOCATIONS
- AGENTS
  1. CHINA
  2. KOREA
  3. JAPAN
  4. MIDDLE EAST

- OFFICES
HIGH PRECISION TUBES FOR DEMANDING ENVIRONMENTS
MEDICAL

SALES OFFICES

Sales Office U.S. West
11631 NE 73rd Street
Kirkland, WA 98033-8107
UNITED STATES

E: medical.superiortube@ametek.com
T: +1 610.489.5200
F: +1 610.489.5252
www.superiortube.com

SALES OFFICES

Sales Office U.S. East
3900 Germantown Pike
Collegeville, PA 19426-3112
UNITED STATES

E: medical.finetubes@ametek.com
T: +44 (0) 1752 876416
F: +44 (0) 1752 733301
www.finetubes.com

SALES OFFICES

Sales Office Europe West
23, Rue Antigna
F-45000 Orléans
FRANCE

E: sales.fr.finetubes@ametek.com
T: +33 (0) 238775-702
F: +33 (0) 238812-407

SALES OFFICES

Sales Office Europe Central
AMETEK GmbH
Rudolf-Diesel-Strasse 16
D-40670 Meerbusch
GERMANY

E: sales.de.finetubes@ametek.com
T: +49 7345 235 9505
C: +49 173 3661337

SALES OFFICES

Sales Office India
AMETEK Instruments India Pvt Ltd
601, Raaj Chambers
Old Nagardas Road
Andheri (East)
Mumbai - 400 069
INDIA

E: sales.in.finetubes@ametek.com
T: +91 (0) 22 6196 8200
F: +91 (0) 22 2836 3613

Disclaimer: The information contained within this brochure is for guidance only and is not intended for warranty of individual application - express or implied.